ENERGY USE ENGINEERING DEPARTMENT

ENERGY MANAGEMENT DIVISION

B.C. Hydro

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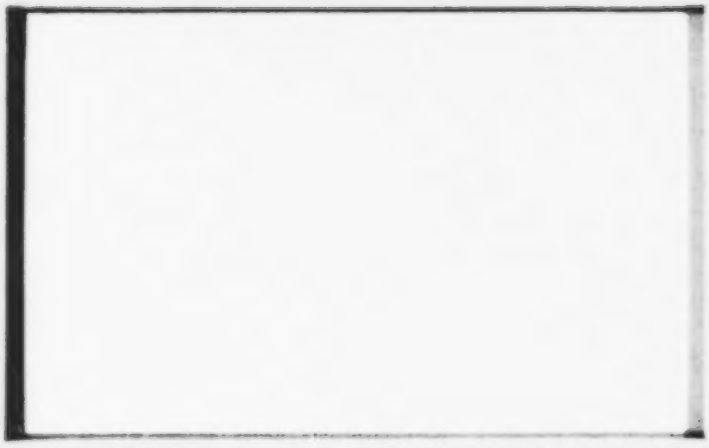

ENERGY USE SERVICES

The Energy Use Engineering Department provides engineering, technical and marketing utilization-point information required for business planning, energy conservation, energy management, marketing and customer service activities.

Information includes electric and gas load characteristics, efficiencies, operating costs, performance and economies; usage trends, trade and industry practice, equipment availability and developing business opportunities; codes and standards; the potential impacts of energy management, alternative services and marketing activities; and customer needs, alternatives and preferences.

The service is provide by a team supervised as follows:

•HEATING, AIR CONDITIONING, VENTILATION & REFRIGERATION TECHNOLOGIES	**Dr. Z. El-Ramly, P.Eng.**	(663-3277)
•ELECTRICAL AND GAS TECHNOLOGIES AND ELECTRIC & GAS INDUSTRIAL APPLICATIONS (including associated total-energy, district and waste energy applications; electric and gas vehicles, power factor and demand control)	**G.D.A. Henriques, P.Eng.**	(663-3286)
•RESIDENTIAL AND COMMERCIAL APPLICATONS CUSTOMER-OWNED ALTERNATE ENERGY SYSTEMS TECHNOLOGIES (including associated appliances, lighting, wiring, water heating, electric and gas vehicles, solar, small hydro, wind, wood, and biomass)	**R.F. Hughes, P.Eng.**	(663-3288)

Please don't hesitate to contact us should you require additional information or should you have any suggestions on how we can better provide the service required.

R.W. RACINE, P.ENG.
MANAGER, ENERGY USE ENGINEERING DEPARTMENT
(604) 663-3268 (TELEX 0454395)

ENERGY USE ENGINEERING DEPARTMENT
ENERGY MANAGEMENT DIVISION
BUSINESS DEVELOPMENT GROUP

B.C. HYDRO
3 - 1265 HOWE STREET
VANCOUVER, B.C. V6Z 2G8

PROJECT 8504
SUMMARY OF RESEARCH AND MONITORING PROJECTS
ON DOMESTIC WATER HEATING SYSTEMS

SYNOPSIS

This report summarizes available Energy Use Engineering and CEA domestic water heating data from past studies and compiles the data into this one project summary report.

PROJECT

Initiated/Requested by:	R. F. Hughes
Date Completed:	February 1986
Completed by:	G. W. Matthews
Supervised by:	R. F. Hughes/Z. El-Ramly

Approved by:

Dr. Z. El-Ramly, Supervisor
Residential & Commercial
Energy Management

IR41.3

Canadian Cataloguing in Publication Data

Main entry under title:
Summary of research and monitoring projects on domestic water heating systems

"Project 8504".
"IR41.3".
ISBN 0-7726-0494-0

1. Water heaters - Energy consumption. I. B.C. Hydro. Energy Use Engineering Dept.

TH6551.S95 1986 696'.6 C86-092108-5

ENERGY USE ENGINEERING DEPARTMENT

PROJECT SUMMARY

PROJECT No. 8504 PRIORITY 1

TITLE: ENERGY USE ENGINEERING DEPARTMENT'S SUMMARY ON THE PERFORMANCE CHARACTERISTICS OF DOMESTIC WATER HEATING SYSTEMS

INITIATED/REQUESTED BY: R.F. HUGHES

ASSIGNED TO: G.W. MATTHEWS ASSIGNED BY: R.F. HUGHES

DATE ASSIGNED: FEBRUARY 1985 DATE REQUIRED: FEBRUARY 1985

ESTIMATED COMPLETION: FEBRUARY 1985 COMPLETED: MARCH 1986

OBJECTIVES AND NOTES:

Combine available Energy Use Engineering and CEA domestic water heating data from past reports and studies, and compile the data into one project summary report.

COPIES TO: DEPARTMENT MANAGER (THEN RECORD FILE), BLUE FILE, SUPERVISOR, (Dr. Z. El-Ramly) A.M. Ferraro

PLEASE ADVISE AS SOON AS POSSIBLE IF CHANGES ARE REQUIRED ABOVE

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1.0 EXECUTIVE SUMMARY

Over the past ten years, there has been a lot of research done on the performances of domestic water heaters. Studies have been conducted by research laboratories, utilities and consultants across Canada. Many of these studies have been jointly funded and supported by the Canadian Electrical Association (CEA).

Because of the large amount of data available on water heater characteristics, this report was written in an attempt to compile and condense this data. The scope of this report looks at CEA Domestic Water Heater Programs as well as our own in-house Energy Use Engineering Programs.

Using the data gathered by this report, further statistical analysis has been done by B. C. Hydro under CEA Project 438-U-SOA which was awarded to B. C. Hydro in November 1984. Completion of the project is expected in spring 1986. The tables below summaries the results of this work.

Table 1 - Summary by Project

Section	Sample Size	Average Persons	Daily Family Hot Water Consumption (L)
2.1 Data	80	3.9	232
2.2 Data	16	3.8	166
2.3 Data	16	3.6	236
2.5 Data	7	4.3	258
2.7 Data	8	3.8	206
3.2 Data	49	3.7	203
Overall	176	3.8	220

Table 2 - Summary by Heating Fuel

	Family Size	Average Annual Consumption
Electric water heaters	3.6	4150 kWh
Natural gas heaters	4.0	32.5 GJ
Oil heaters	4.0	1000 L
Propane heaters	3.4	1310 L

2.0 EUE DOMESTIC WATER HEATING PROJECT SUMMARIES

The Energy Use Engineering Department (EUE) of B. C. Hydro has been monitoring domestic water heating systems for many years now. Many different types of water heating systems have been monitored, providing us with a good domestic water heating data base. Solar heat pump, grey water waste heat and dryer exhaust heat assisted systems are just a few of the many monitored systems.

EUE monitoring results indicate that without the use of any outside energy sources (i.e. solar, wood, waste heat, etc.) the annual energy consumption for electric and gas residential water heaters are as follows:

	Consumption	Range
Electric	4,850 kW.h/yr	2,200 kW.h to 6,500 kW.h/yr
Gas	32 GJ/yr	26 GJ to 52 GJ/yr
	Annual Average	*Daily Average Per Person
Hot Water Use Data	76,500 Litres (16,800 Imp.Gal.)	60 Litres (13 Imp.Gal.)
Average Hot Water Temperature	55°C (132°F)	

*3.5 occupants per household.

2.1 Project 8033 - Coordination of the Ministry of Energy 100 Solar Domestic Water Heating Project

The B. C. Ministry of Energy has recently concluded a project in which it has installed 94 solar assisted water heating systems in B. C.

B. C. Hydro was asked to provide and install energy information meters required for this project where the installations are in the Hydro service area. The cities involved are Vancouver, Victoria, Nanaimo, Fort Nelson and Cranbrook.

Included in this report is finalized details of the number of applications, type of solar system and backup heating system.

Originally, 100 B. C. test homes were scheduled for the monitoring project, but only 94 solar domestic hot water systems were actually installed. The monitoring period for the project was two years. The sites ranged from mild coastal locations to interior locations with wide seasonal temperature fluctuations. Three main systems were tested: drainback with coil heat exchanger; drainback with tank-in-tank heat exchanger and closed-loop antifreeze.

The systems were designed to provide 50% of the hot water energy requirements of the test homes. The results indicated that the systems are capable of that performance in all the cities. However, most installations produced a lower solar contribution. The main contributing factors were: higher hot water set point temperatures than expected, consumption of gas and propane by pilot flames, high quantities of hot water usage at some sites, and quality of the installation work.

Of the 94 test homes, 59 used electric water heaters as their backup heating system; 27 used gas, 5 used oil while the remaining 3 used propane water heaters.

Results show that without the use of solar energy the electric and gas water heaters being monitored would have consumed the following:

	Consumption	
Electric Gas Average Hot Water Temperature	4,560 kW.h/yr 34 GJ/yr 55°C (132°F)	
	Annual Average	*Daily Average Per Person
Hot Water Use Data	82,850 Litres (18,200 Imp.Gal.)	60 Litres (13 Imp.Gal.)

*3.8 occupants per household.

2.2 Project 8039 - Monitoring of the Performance Characteristics of Residential Water Heaters

This report discusses the performance characteristics of 16 residential water heaters which were studied over a two and a half year period. The average usage patterns based on a sample of 12 gas water heaters and four electric yielded the following:

Gas		Electric	
Average Family Size 4.2		Average Family Size 2.3	
*GJ/Heater	29.3	kW.h/Year	2,205.0
GJ/Person/Year	6.9	kW.h/Person/Year	961.0
Efficiency	51.6%	Efficiency	84.8%
Hot Water Temperature	61.0°C	Hot Water Temperature	61.0°C

The average amount of hot water used for the 16 test homes was 71,540 litres (15,740 Imp. Gal.). The typical number of occupants per residence was 3.75, giving us an overall daily hot water usage figure of 52.3 litres (11.5 Imp. Gal.) per person.

*Gigijoules

Further results show that for a 182 litres (40 Imp. Gal.) electric water heater, almost 400 kW.h of energy could be saved each year from standby losses when reducing the hot water tank thermostat setting from 71°C (160°F) to 49°C (120°F). The use of an additional insulation jacket showed that for a tank heated to 60°C (140°F), putting on an RSI 1.7 (R10) jacket could result in a yearly savings of almost 325 kW.h.

For a 150 litre (33 Imp. Gal.) gas water heater, results show that almost 7.4 GJ of energy could be saved each year from standby losses when reducing your hot water tank thermostat setting from 71°C (160°F) to 49°C (120°F). The use of an additional insulation jacket showed that for a tank heated to 60°C (140°F), putting on an RSI 1.7 (R10) jacket could result in a yearly savings of almost 2.3 GJ.

The use of a flue damper used together with a static ignitor for a tank heated to 60°C (140°F), can result in a yearly savings up to 9.5 GJ. When using a timer on water heaters, savings involved are completely dependent on the water demand of each household. Energy savings are most noticeable when a timer is on for less than six hours per day thus limiting the amount of hot water available. This, of course, requires a change in living habits.

2.3 Project 8040 Series - Energy Use Engineering Update on the Monitoring of Solar Systems in B. C.

The EUE Department of B. C. Hydro has made a commitment to monitor different types of solar applications throughout B. C. The objective of the program was to find out what impact such systems have on our electric and gas systems. Solar availability, equipment performance figures and potential energy savings to the customer were also looked at.

At the end of 1984, the EUE Department was monitoring slightly over 100 residential and commercial solar installations. The monitoring boundaries are within the province of British Columbia but principally within the five Hydro regions. All the monitored systems are categorized into different groups according to application use and Hydro region.

Presently, EUE is monitoring 22 solar space, 61 domestic water heating and 21 pool heating systems. Several reports have already been written to provide update information on the system performances.

From the domestic water heating systems monitored, results show that without the use of solar energy the electric water heaters being monitored would use approximately 5,580 kW.h of energy per year (31.50 GJ for gas water heaters) to heat an average of 70,400 litres (15,490 Imp. Gal.) of hot water per household to a mean temperature of 56°C (133°F). This works out to be 54.5 litres (12.0 Imp. Gal.) of hot water used per person per day for all the test homes.

2.4 Project 8229 - Monitoring of a Residential Heat Pump Domestic Water Heating System

The Energy Use Engineering Department of B. C. Hydro has been monitoring the energy utilization data of a heat pump domestic water heating system in the Vancouver area for 12 consecutive months.

A typical family of four (husband, wife and two children), lived in the test home. During these 12 months, 101,100 litres (22,245 Imp. Gal.) of hot water was used at a temperature of 45°C (114°F). This works out to be 69.1 litres (15.2 Imp. Gal.) of hot water used per person per day.

3,640 kW.h of energy was consumed by the heat pump for the purpose of heating the domestic water. A conventional electric water heater under similar water demand load would consume approximately 5,200 kW.h.

Such heat pump units used for the purpose of heating domestic water would lend themselves quite well in residential, commercial and industrial areas where air conditioning and water heating is required on a year-round basis.

2.5 Project 8328 - CGRI Energy Efficient Gas Water Heater Monitoring Program

B. C. Hydro participated in a joint program with the Canadian Gas Research Institute Association (CGRI) . The program was started to monitor the performance characteristics of ten energy efficient (EE) gas water heaters manufactured by John Woods of Canada. These heaters were installed in ten test homes in the Lower Mainland with three to four persons per family. Hot water usage and energy utilization data was recorded and compared to conventional gas water heaters under similar operating conditions.

Preliminary results show that the EE gas water heaters were approximately 6% more efficient (typically 60%) than conventional ones. Further results showed the following:

	CGRI Gas Water Heaters	Conventional Gas Water Heaters
Gas Consumption	26 GJ/yr	28 GJ/yr
	Annual Average	*Daily Average Per Person
Hot Water Use Data	82,150 Litres (18,100 Imp.Gal.)	60 Litres (13 Imp.Gal.)
Average Hot Water Temperature	60°C (140°F)	

*3.8 occupants per household.

2.6 Project 8339 - High Level Monitoring of a Residential Solar Domestic Water Heating System

The EUE Department has been monitoring the performance characteristics of a residential solar domestic water heating system using an automatic data acquisition system. The logging of the system data started in June 1981 and ended in December 1982.

The in-depth monitoring of this solar domestic water heating system using extensive monitoring equipment and sensors etc. enabled EUE in determining the accuracy of our level one monitoring. This level one monitoring is used extensively throughout all our departmental monitoring and to prove the accuracy of the monitoring techniques, would project confidence to trades, customers and others in our estimates, conclusions and recommendations. This monitoring also enabled us to see actually when the backup heater (in this case natural gas fired) was required during the day. With this information, it can be noticed that by the use of solar assistance, the electric energy requirements for electric water heaters throughout the province (particularly on Vancouver Island) might be deferred past the 5:00 p.m. to 7:00 p.m. peak energy time period and possibly the 7:00 a.m. to 9:00 a.m. period as well.

Results show that over the 19 month monitoring period, the solar system utilized 38% (40% for 12 months) of the solar radiation incident on the collector array. The solar fraction or solar contribution to the hot water heating load was 47.5% (51.2% for 12 months).

Without the use of solar, the gas water heater would have consumed 52.5 GJ of energy per year to heat 93,580 litres (20,590 Imp. Gal.) of hot water to a temperature of 54°C (130°F). This works out to be 64.1 litres (14.1 Imp. Gal.) of hot water used per person per day.

One other concern was that if an all electric home were built, the savings by not installing gas service (because of bi-monthly service charge) would be offset by the increased electric domestic water heating load. This increase is approximately twice that of gas water heating loads for a typical family of four. As mentioned earlier, the annual solar contribution as was recorded by our solar test home in this study was 51.2%. This figure being well within the range of other B. C. Hydro monitored solar systems, indicates that if new and existing all electric energy efficient homes utilized solar domestic water heating systems, they would have the same or better operating costs as if their water heating systems were gas fired.

2.7 Project 8109 - High Efficiency Gas Furnace Field Tests

This project was initiated to carry out field tests on new intermediate and high efficiency natural gas furnaces. The primary goal was to assess their energy saving potential, however, when possible domestic water heating was also monitored.

Eight gas water heaters were being monitored from the 41 furnace test homes. The recorded data included the hot water temperature settings, natural gas energy consumption and the hot water utilization figures. The results are tabulated below:

Natural Gas Water Heating	Data
Average Family Size	3.8
GJ/Heater	33.8
GJ/Person/Year	8.9
Daily Hot Water Usage Per Family	206 Litres
Average Hot Water Temperature	57°C

The average amount of hot water used for the eight homes was 75,190 litres (16,545 Imp. Gal.). With an average family size of 3.8 occupants, the daily hot water usage figures per person was 54.2 litres (11.9 Imp. Gal.).

3.0 CEA DOMESTIC WATER HEATING PROJECT SUMMARIES

Over the past several years, CEA has also been studying the performance characteristics of water heaters. There have been jointly sponsored programs with various utilities, research laboratories, appliance manufacturers and consultants, in addition to their own in-house studies.

Programs conducted by CEA included the collection of energy utilization data for standard conventional electric water heaters; waste water heat recovery; improved energy efficient water heaters, etc.

Results show that a typical family of four uses about 225 litres of hot water per day, requiring an annual electricity consumption of 5,000 - 7,000 kW.h. Energy losses from electric water tanks were typically around 1,000 kW.h/yr. If 5 cm (2 in) of normal fiberglass insulation were added to existing conventional electric water tanks, a savings of approximately 200-300 kW.h/yr would be experienced. Insulating the hot water distribution pipes would produce an approximate savings of 15-20 kW.h/yr, for each meter of piping.

The range of annual energy consumption to produce domestic hot water in single family residences were typically 1,115 litres (245 Imp. Gal.) of heating oil for oil water heaters, 34.26 GJ for gas water heaters and 1,320 litres (290 Imp. Gal.) of propane for propane water heaters.

From a questionnaire diary survey that was conducted, it was noted that showers used 41% of the total hot water, washing machines used 24%, baths used 17%, dishwashers 10% while the remaining 8% was for hand washing and manual dishwashing. 54% of the 621 survey participants owned dishwashers, while 51% owned both dishwashers and washing machines.

3.1 Project 77-51 - Improved Energy Efficient Water Heater

This study has attempted to put into perspective the various energy expenditures encountered in the manufacture and utilization of domestic hot water heaters. The report also simulates the capability of various electric water heaters to meet particular hot water demand.

Results show that a typical family uses about 225 litres (50 Imp. Gal.) of hot water per day, requiring an annual electricity consumption of 5,000 - 7,000 kW.h. Energy losses from the hot water tanks range typically around 1,000 kW.h per year. Substantial savings of 300-400 kW.h/yr would result from improvements in the level of thermal insulation, either by the addition of an extra 5 cm (2 in) of normal fiberglass, or by the replacement of the existing fiberglass with "double density" fiberglass or with polyurethane. With the installation of a simple heat trap, 40 kW.h/yr are the expected savings. Insulating the hot water distribution pipes with 1.3 cm (½ in) thick fiberglass insulation would give an approximate savings of 15-20 kW.h/yr, for each meter of piping.

Electric water heaters, in most cases, last about 8-10 years. The energy required during manufacturing is approximately 900 kW.h/unit. The life of a hot water tank ultimately depends on the life of the anode, which in turn depends on the initial enamel coverage and durability. Improvements can be brought about by improving enamalling practice and by reducing the area of bare metal presently permitted around fittings, and if necessary, by coating excess bare areas with a plastic resin. These improvements would require little additional energy input.

3.2 Project 913-U-160 - Determination of the Energy Required to Produce Domestic Hot Water

In this project, 51 residential water heaters were monitored over a one-year period in an effort to improve the understanding of the energy required to produce domestic hot water.

The energy consumption, hot water consumption, and the inlet water, water storage and ambient air temperatures were monitored at each test installation. The values were available from each residence for each day or week over the one-year monitored period. For the purpose of comparing the energy consumptions, the oil, natural gas and propane consumptions were converted to kW.h equivalent by using the appropriate fuel heating values and the conversion constant of 3,412 Btu/kW.h.

The effectiveness of energy use was evaluated on the basis of the value of unit production (hot water produced per unit of energy consumed in litres per kW.h) as calculated from the measured energy and hot water consumptions.

The evaluation of the interrelated effect of the various parameters on the energy consumption, unit production and efficiency was performed by deriving equations as functions of the parameters and other necessary factors as determined from energy balances for the water heaters. The accuracy of the equations were tested by comparing predicted and measured values. Computer programs were written to facilitate the large number of calculations necessary for verifying the equations. For the electric water heater equations, the accuracy was determined to be within plus or minus 1.0%. For the combustion based water heater equations, an accuracy within plus or minus 5.0% was determined. The equations could be used for any combinations of parameters.

The cost of the energy for producing hot water was determined for each installation based on the annual energy consumption and the applicable rate structures in effect during the monitoring program.

Based on the project results and analyses, the following conclusions are made:

(a) Range of energy consumption to produce domestic hot water in single family residences:

Energy Source	Range	Equivalent kW.h
Electricity	2,000 to 8,000 kW.h per year	2,000 to 8,000
Furnace Oil	120 to 370 Imperial Gallons	5,900 to 18,200
Natural Gas	13 to 56 Gigajoules	3,600 to 15,600
Propane	160 to 420 Imperial Gallons	5,200 to 13,500

For similar operating conditions (250 litres/day of hot water usage at a water storage temperature of 65°C [150°F]), the energy consumptions are approximately 7,740 kW.h/year, 1,340 litres (295 Imp. Gal.) of oil per year and 50.8 GJ (48,200 standard cubic feet) of natural gas per year.

(b) The hot water consumption and the storage temperature are the most significant controllable variables influencing the energy consumption of water heaters. There is considerable variation in the energy required to produce DHW. The energy consumption can be reduced significantly by lowering the storage temperature to the minimum value acceptable to the occupants and by minimizing the volume of hot water consumption.

The energy savings due to reduced hot water consumption and storage temperatures can be calculated using the derived equations.

(c) Electric water heaters apply energy more effectively than oil, natural gas and propane water heaters.

Range of unit production of domestic hot water in single family residences.

Energy Source	Range Litres/kW.h (Measured)	Production at 250 Litres/Day and 65°C (150°F) Storage Temperature (Calculated) (Litres/kW.h)
Electricity	11.2 to 21.1	11.8
Natural Gas	6.0 to 12.5	6.5
Furnace Oil	4.2 to 9.2	6.4
Propane	4.9 to 11.1	

(d) The user's cost of energy (electricity, natural gas or furnace oil) for domestic hot water is, in the majority of cases, between $100 and $300 per year, using the prices for energy in effect in 1980.

3.3 Project 111-U-268 - Vol. I & II Residential Hot Water Use Patterns

Volume I

This report presents the findings of a market research project undertaken to establish average and typical daily patterns of residential hot water usage in Canada. The results are then compared to those of a previous study, on which the current CSA standards have been modelled.

The objective was to develop generalized usage patterns and not to emphasize peak user requirements or adequacy of current water heater designs. Also, the study sample was not

restricted to electric heaters although some of the tabulations were made for a sub-set of electric heater respondents.

In this study residential hot water use patterns are developed and analyzed using a market research approach and the recording, over a two-week period, of the times and types of major hot water uses in over 600 single family homes across Canada.

Panel members living in multi-family dwellings (other than semi-detached and duplex housing) are eliminated from the sample. The numbers sampled in each region are further adjusted to give reasonable numbers of electric hot water heaters for statistical analysis.

The data in a questionnaire and two-week diary are cross-tabulated with demographic characteristics of the survey respondents and the resulting information analyzed. The cross-tabulations are also made for the frequency of use of appliances, cycles selected and other major hot water uses. Some interesting trends are evident from the tabulations.

(a) Colder water temperature settings for clothes washing/rinsing are used in a majority of households.

(b) The incidence of automatic dishwasher and clothes washer ownership is relatively high in the respondent group, with 51% owning both appliances and close to 54% owning dishwashers. These figures are certainly influenced by the fact that apartment dwellers are not represented in the sample.

(c) The average length of showers taken was longer than might be expected and when households with children over ten years old present are isolated in the sample the average length reported is significantly longer than the average.

The following summarizes the estimated number of litres consumed by each major use over the two-week reporting period.

	Litres Used (Hundreds)	% of Total
Baths	2,360	16.5
Showers	5,826	40.7
Washing Machines	3,462	24.2
Dishwashers	1,392	9.7
Manual Dishwashing	1,263	8.8
Total	14,303	100.0

The quantities consumed are next tabulated by time of day in order to establish the hourly patterns of use. Several groupings of respondents are made in order to analyze variations in the patterns of use and quantities used from the overall survey averages. A comparison is given below of several daily usage totals.

	Number In Group	Average Day	Peak Day
Low Use Group	393	95.7	116.2
High Morning Use	88	263.8	292.3
High Evening Use	140	272.0	301.8
"Typical" Group	203	192.0	239.0
Total Sample	621	159.3 L	183.0 L

The daily patterns, when compared with the CSA Draw Schedule or the patterns established from a similar survey carried out in 1970 indicate a significantly lower peak requirement and a slight shift of the daily peak requirement to a point one to two hours earlier in the draw schedule. The significance of these changes is that the traditional mid-morning peak hour

hot water requirement is reduced significantly and shifted to an early morning peak. This places a major portion of the total daily draw within a relatively short period in the morning. It is expected that future efforts will be directed at determining the capability of various water heaters to meet this draw schedule.

Volume II

This volume has been prepared as a supplement to Volume I, which is the main research project report titled "Residential Hot Water Use Patterns". Volume II contains detailed tabulations of data obtained from the questionnaires and two-week diaries of major household uses of hot water. A total of 621 responses are included in the tabulations, representing a cross-section of Canadian single-family dwellings. The period covered in the diaries is 5 - 18 May 1982.

3.4 Project 101-U-246 - Residential Wastewater Heat Recycle Water Heater Development

This study was the development of a production prototype household water heater appliance employing wastewater heat recovery. The new appliance is a single unit encompassing both wastewater tank and heat pump which acts as an "add-on" to a conventional Cascade 60 electric resistance water heater. The unit was thoroughly bench tested and full production drawings are available but presented only in a limited edition.

This device, at electrical rates prevailing in most of Canada, is not quite yet economical in terms of a short enough payback period: currently about five years. The payback period may well be considerably reduced by future electrical rate increases, as well as by any significant production cost reductions which may be expected to occur. The device may well be a saleable item now in regions where electrical costs

are relatively high. The study showed that there was indeed sufficient recoverable heat in a household's wastewater to heat all its DHW requirements by this technique and potential energy savings in DHW generation of 60 to 70% could be expected. (Savings of approximately 3,700 kW.h/yr for the average Canadian home.)

The market study suggested that there would not be much of a market for heatcatchers in North America but did leave some room for hope in the areas of heatcatcher cost reductions and electric utility supply price escalation. Additional benefits were shown to accrue from the electrical load-levelling ability of the system and the likely cheaper cost of conservation measures compared to the cost of creating new generating capacity.

4.0 CONCLUSIONS

Research to determine the performance characteristics of residential domestic water heaters has been ongoing for many years. Much work has been done by research laboratories, utilities and consultants across Canada. The Canadian Electrical Association (CEA) has also been heavily involved in such studies.

This report analyses the data from research done by B. C. Hydro and CEA which was obtained from over 800 residential domestic water heating test homes located throughout Canada. Overall domestic water heating energy consumption figure results are as follows:

Heater	Average Annual Consumption	Family Size
Electric water heaters	4150 kWh	3.6
Natural gas heaters	32.5 GJ	4.0
Oil heaters	1000 L	4.0
Propane heaters	1310 L	3.4

The average hot water usage per household was 80,300 litres (17,700 Imp. Gal.) with an average hot water temperature of 60°C (140°F). This annual hot water usage amount corresponds to a daily hot water consumption figure of 58 litres (13 Imp. Gal.) per person.